The Shore Route, (No. 4) near Middletown

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Macadam paving which has been maintained with Tarvie "B", at Lenox Avenue, Westfield, N. J.

Note

The papers presented at the last Convention of the New Jersey Highway Association, and the discussions following them, are such a valuable contribution to the progress of road-building that it has been decided to publish them in full with as many as possible of the charts and illustrations used. (It has not been possible to include all of these, however, so there are occasional references in the text, to photographs and charts which have not been reproduced).

Our aim is to publish one or two of the Convention papers, with the discussion thereon, each month. We suggest that these be carefully filed, so that the reader may keep the complete set, which will make a very valuable addition to his road-building library.

This month we are printing "Refined Tars in Maintenance and Construction," by Philip P. Sharples, Technical Adviser, The Barrett Company, and the discussion thereon at the convention; "Purposes and Practices of the Asphalt Association", by Joseph R. Draney, President of the Asphalt Association, New York City, and the discussion thereon at the convention; and Contract News.

Next month there will be published "The Advantages Secured by Sealing a Bituminous Concrete Pavement with a Hot Sand Mixture", by G. H. Perkins, M. E., and the discussion thereon at the convention; also "Proper Methods to Follow in the Control of Paving Mixtures", by H. S. Mattimore, Engineer of Tests, Pennsylvania State Highway Department, and the discussion thereon at the convention; and Contract News.

Refined Tars in Maintenance and Construction

By Philip P. Sharples, Technical Advisor, The Barrett Company

The maintenance problem in the long run is the most important problem that faces the road engineer. Just at present it is being neglected by many engineers owing to the clamor for new construction. New construction carries with it an interest and a prestige that are sadly lacking in maintenance problems. It is much more fun to build a new road than to take somebody's cast-off road and try to make it suitable for modern traffic, oftentimes with a lack of adequate funds to do it with. Yet it is not conceivable that any road supervising body will construct or reconstruct fundamentally more than 5% of its mileage annually. This leaves the remaining 95% that must be taken care of annually, if the original investment is to be preserved. Stated in figures, the State Highway Department and the counties of New Jersey might build 150 miles of road, but they have some 2,850 miles to maintain.

The cost of maintaining modern highways under modern traffic conditions is an unknown quantity. An analysis of the figures of any of our State Highway Departments leads to no just conclusion. Figures may be twisted almost any way to prove any particular proposition. I venture to say, however, that in the long run, provided a road is not overloaded for its type, and provided that it is carrying the load of traffic for which it was designed, that the cost of upkeep through a period of say 20 years, will be somewhat proportional to the original cost of the road. I know this is diametrically opposed to the prevailing popular notion on this subject, but an analysis of figures covering roads on which the traffic conditions are manifest, leads to this conclusion. On the one hand, extremely high costs are assigned at present to the simpler forms of paving like macadam, and extremely low costs are assigned to some of the modern rigid types of paving. Unless sufficient time has elapsed to prove the length of life of the rigid type road, it would be unsafe to predict the maintenance cost. On the other hand, the costs on the macadam type are generally arrived at by adding in the cost of rebuilding, or reconstructing an old worn-out macadam to resist modern traffic.

In almost any community where macadam roads already exist, a little study will show that this type of road when properly looked after, is adequately carrying a large traffic at a low cost per ton mile. Their unsatifactory condition in most cases is due to utter neglect and a thorough misunderstanding of the economic factors in the case. A little consideration will show that if it is possible to make a macadam road stand the traffic imposed upon it, that it pays handsomely to spend even as much as a thousand or fifteen hundred dollars a mile per year on it, rather than to replace it with a pavement that would cost forty or fifty thousand dollars per mile.

The rehabilitating and traffic-proofing of the macadam road is peculiarly the province for tar materials. Much study has been given to the production of materials suitable for patching work, for surface treating work and for use as a binder in cheaply constructed bituminous macadam tops that are suitable for strengthening old macadam roads.

The maintenance of macadam roads by surface treatments was originated with tar materials. Improvement in the refined tars and in the equipment used, has kept these materials at the front for this class of work. The tars have a penetrating power beyond all other bituminous materials used for this purpose and also have the peculiar quality of setting up, that seems to render them to a considerable extent immune from shoving and waving troubles incident to the use of other bituminous materials.

The use of surface treatments cannot produce a good road out of one that is worn out. They cannot give a smooth surface to a road that is in need of surface repair. Surface treatments can, however, preserve macadam roads which are strong enough to uphold the traffic that goes upon them from the surface wear and tear of self-propelling vehicles. In other words, surface treatments should be applied to macadam roads for their protection before the roads have worn out. If the macadam has worn thin or has ground up internally, it must be rebuilt before the surface treatment will give satisfaction. As a rule, surface treatments in New Jersey on old macadam roads have not given as good results as surface treatments in New England. The reason must be assigned to the almost universal practice of using clay as a binder for macadam roads in New Jersey, a practice that was never carried out in New England. New Jersey with the finest trap rocks in the world for building macadam should have the very best results with surface treatments if the roads are built properly to receive them. The macadam road with a surface treatment is still the most economical type to build for many types of traffic. It cannot be excelled in first cost or in low cost of maintenance where there is a preponderance of light weight traffic.

Two types of tar materials have been developed for surface treatment; a material which must be heated before application, and a material which is thin enough to apply cold. Under general conditions, the material which is to be applied cold gives the lowest yearly maintenance cost and is to be preferred. For certain park and boulevard conditions, however, the hot surface treatment gives the lowest unit cost through a series of years. The local factors must be thoroughly studied to see whether it is more economical to pay less for a comparatively short-lived treatment or to pay more for a more lasting treatment. The material applied hot may sometimes be used advantageously with semi-resurfacing methods. Its greater binding power and longer lasting qualities make it particularly adapted for this purpose.

The cost of surface treatments varies with the condition of the surface, the amount of refined tar required and the type of work decided upon. Simple surface treatments of refined tar applied cold over roads already in good condition may be made very cheaply. However, if much repair work is to be done, or if the surface of the road must be worked over before the bituminous material is applied, the cost will mount rapidly. If the work required on the surface is extensive, it may be very much cheaper in the long run to scarify the surface, add new stone and practically build a new top by the penetration method. In this case, a heavier material, a road binder, is required.

It is quite astonishing how much can be done by the use of the modern repair roller fitted with a steam scarifier. Too little attention has been given, especially by municipal and town engineers, to the possibilities of this type of work using tar binders, and few are aware of the low cost coupled with extremely satisfactory results that can be obtained by these methods, especially where truck service supplying hot binders can be obtained.

In conversation lately, a city engineer stated that the penetration topping of old macadam roads has been entirely too successful in his town, since it had absolutely killed all petitions for higher class pavements. The people were so entirely satisfied with the work done that they had no desire to pay for any other kind of improvement, and his plan of extending high priced pavements had been sadly interfered with. The property owner was, however, getting pavement service at a minimum cost, and this is the true mark of good engineering.

The tar binders have proved themselves equally serviceable in the building of new macadam roads. Tar binder has peculiar advantages for use in penetration work; it is strongly adhesive to cold stone; it re-unites easily if the bond is broken during rolling; it is easily liquified by steam heat so that it may be applied effectively by spraying equipment; and it can be used success-

When constructing penetration Macadam pavement, the hot bitumen is applied by means of a pressure distributor, in the manner shown in above picture taken on the Budd Lake Job.

fully with a great variety of stone. It also can be used earlier in the season and later in the season than other bituminous materials since it is less affected in its application by cold and dampness.

The penetration method is looked upon by some as a very crude operation and therefore not worthy of much study. It is true that it is a form of construction easily mastered but that does not prevent penetration work being badly done in many instances. The cardinal principles to be observed are simple, but certain fundamentals must be carefully carried out to produce perfect pavements. Really good penetration work, constructed with rocks like the Jersey trap rocks, carry a surprisingly heavy traffic at a low cost of maintenance. Stretches of bituminous macadam on the most traveled Maine State Highways have shown the lowest annual maintenance cost for any type of pavement. The type has a certain resiliency to it which enables it to stand temporarily overloading without damage, better than more rigid types of pavement. Even when damaged, provided it was originally well built, it can be brought back into serviceable condition at a comparatively low cost. This is not true of other types of paving of equal resisting power.

Penetration macadam with tar binder has proved a very efficacious method for widening existing hard surface types of paving. It is also employed, as on the Lincoln Highway near Metuchen, for shoulder work on new pavements. The shoulders of hard surfaced pavements with definite edges are peculiarly hard to maintain: Wheels dropping off of the hard surface, quickly form dangerous ruts. A strip of bituminous macadam, however, resists the occasional wheel dropping off the surface, and may be maintained level with the pavement at comparatively slight expense.

Where traffic becomes more crowded, the bituminous shoulder in reality provides a practical widening of the pavement at small cost. The methods employed in penetration macadam construction are easily modified so that strips, even as narrow as 18 inches may be economically constructed. In Wayne County, Michigan, some 60 miles of this type of shoulder have been installed with satisfactory results.

Repair work of all kinds is at present being carried on successfully with tar materials. The older types of materials, the hot and cold surface treatments and the binder, are used in many kinds of repair work and in protecting other types of pavement than macadam. The cold surface treatment has been found very effective in protecting certain types of gravel. The gravel, however, must be made up of a considerable proportion of pebbles one inch or thereabouts, and must contain a minimum amount of clay, the limit of which is usually set at 15%. The nearer the gravel approaches a macadam pavement in construction, the more sure the surface treatment is to be successful. Extremely interesting work along these lines has been done in Maine and New Hampshire in protecting the State Trunk Lines from the summer automobile traffic, where the resistance of the gravel road has been increased from 200 or 300 automobiles a day to 2,000 or 3,000 automobiles a day. The methods have, however, not been found applicable to the gravel of Southern New Jersey.

Cold surface treatments have been developed to successfully take care of bituminous macadam, bituminous concrete and even wood block pavements.

The low cost of maintenance of surface treatments and of penetration macadam is dependent largely on well developed patrol or gang maintenance systems. Surface treatments are liable to give way to weak spots in the road below and unless these are early patched, serious damage may result to the road. The work of patrol and gang maintenance has been made much more effective by the development of cold patching material. A cut-back tar product has proved particularly effective. The tar material mixes easily with the stone, seasons out quickly, and produces a patching compound which sets up solidly in the patch with little or no tendency to develop waves. Since it may be used cold, barrels of the material may be stored and used at convenient places along the roads, ready at all times for instant use. The cold patching material and mineral aggregate may also be mixed beforehand at central points, stored for future use, and carted out as required upon the road. Central storage plants, using an ordinary small concrete mixer to mix the batches have proved particularly effective in town and city work. With this material available, there is no excuse for any city or town neglecting its repair work and letting the streets get into condition dangerous for traffic. Properly mixed and graded material may often be used in making temporary repairs on heavy duty pavements, until it is convenient to put in more permanent work. It has been used successfully on streets like Broad Street, Philadelphia, carrying the heaviest traffic of a large city. Some of these temporary patches, overlooked in the permanent repairs, have carried traffic for a year or more.

The best results can only be obtained by careful attention to detail. The mixes must be rightly proportioned, and the work carried out in an intelligent way. Many cities now have repair gangs trained in this kind of work which patrol the streets carefully in order to make quick repairs wherever necessary. This kind of work has been found to pay handsomely and the repair gang's expenses are saved many times over in the longer service given by the pavement, and the pavements instead of being spasmodically good and generally bad, are at all times kept in good condition.

General Discussion of Mr. Sharples' Paper

COL. WHITTEMORE: I am sure that we were very much interested in hearing these remarks on this interesting subject. Are there any questions?

I would like to say in this connection that in Sussex County about 10 years ago a piece of road was built by the penetration methods. The penetration material was put on by hand, and although it is generally considered highly desirable that the stone be dry and the weather warm, I am informed that during a portion of this work, snow fell while some of this material was being poured. The work was done about 10 or 12 years ago, and is that section running from Hamburg over the mountain to Stockholm in Sussex County. That road today is in excellent condition, subject to the traffic that comes over all kinds of highways, some very heavy and some light. There are other penetration roads that have not been down two years and they are beginning to show bad pot holes. It makes a difference how a penetration road is built.

If Mr. George is present he can say something of interest to those who are here. It was built by the Shanley Brothers Company under Mr. George.

I also want to call attention to a remark that was made, and that is about binding the stone material in macadam roads. I have built some macadam roads and have always maintained that the proper way to build a stone road was to use stone. While there are many persons who have built stone roads successfully by the use of a certain amount of clay material to bind, clay retains moisture, and in cold weather the moisture freezes and expands and the road goes to pieces. I heartily agree with the statements of the speakers that clay is a bad material in a stone road. If you want to make use of modern treatment, keep out the water.

MR. WATSON G. CLARK: I would like an opportunity of correcting a statement made by the last speaker, of treating macadam for about 2 or 3 cents a square yard. Unfortunately, I come from the northern section of the State, where we pay from 15 to 16 cents a gallon for use of tars, and the best I could do for the last two years was 7 or 8 cents a square yard for surface treating macadam. It maintains up to about 7 cents with Tarvia B. I agree heartily with the Chairman when he says that correct road construction is entirely an engineering problem. The State of New Jersey from Sussex to Cape May has practically every character of sub-soil. Roads that would stand up in northern New Jersey would be highly expensive in the southern part of New Jersey when cheaper construction might be possible. However, I think that to try to build a fine permanent bituminous concrete surface on an ordinary waterbound macadam road, under the present growth of motor traffic would be a serious mistake at the present time. It would be something like putting a slate roof on a hay stack. If you build an ordinary well-constructed water-bound macadam road and start heavy traffic over it, no matter how well-preserved the surface, the stone in the foundation, due to the vibration, is going to disintegrate. If you lay a 2 in. top on a water-bound foundation, you are going to reduce but slightly the vibration of the stone in your foundation and gradually the stone will disintegrate.

On the road from Edgewater Ferry to the Hill they were obliged to make some cuts for sewer purposes less than three or four years ago. They took pains to measure the stone in the whole foundation. There was at least 2½ in. of the old macadam that had gradually disintegrated during the time that the road was maintained under macadam base treatment. Of the 2½ in. stone that was laid, when it was examined there was not a stone in that foundation that was larger than ¾ in. and most of it was dust. You can realize what vibration there is when a truck passes by you while standing on a side-walk. If it was not for the vibration, the stone would not disintegrate. In Bergen County we laid, about five years ago, a large number of bituminous concrete pavements on waterbound macadam. These roads stood up beautifully for three or four years ,but as is the case all over the State, good roads soon develop the population. Motor busses began to run and it was surprising how soon these roads went to pieces when constantly being pounded every fifteen or twenty minutes under heavy bus traffic. It is a serious mistake to put a bituminous concrete road down unless the foundation is bound with either bituminous penetration or is of concrete. In that connection, I would like to say that best results have been obtained in our section where we have to take economy into consideration and use penetration, by using tar penetration foundation, covering the top with either asphalt or Amiesite. You can get tars quite cheap in Northern New Jersey, and they penetrate, as the speaker says, much more readily than asphalts. On top of that, I have built a good many roads using Amiesite top, and in other cases using an asphaltic treatment. I recall one instance where I put down nearly a mile of road, using 6 in. tar penetration and treating with a Squeegee coat. The road was subjected to tremendous traffic, and is only now being repaired after seven years of service. It cost 65 cents a square yard.

MR. DRANEY: Which of those roads in Bergen County have gone to pieces laid by Mr. Clark five or six years ago?

MR. CLARK: I spoke of the road paralleling the Hackensack River, from Hackensack to Westwood.

MR. DRANEY: I think the major portion of that road is in very excellent shape.

MR. CLARK: Those roads were subjected to extra heavy truck traffic, and were laid on water-bound macadam and show a very general deterioration.

MR. DRANEY: I have in mind a piece of road from Hohokus to Allendale, laid on macadam eleven years ago, which is in very good shape now.

MR. CLARK: That has not one-half the traffic of the road I speak of.

MR. DRANEY: I would refer to 5th Avenue, New York?

MR. CLARK: That is nothing but light automobile traffic.

MR. DRANEY: I would call attention to an example of asphalt on macadam, and that is the Grand Boulevard, Detroit, Michigan, which circles the town. This was laid nine years ago and the repairs have been comparatively none. It has about as much traffic as any boulevard in the country, because the Packard, Dodge Bros., and innumerable other factories feed it with trucks all day long. Traffic census shows at least 10,000 to 15,000 a day.

Springfield Avenue at Summit, N. J., which was treated with Tarvia "X" in 1917, and has been maintained since with Tarvia "B"

Purposes and Practices of the Asphalt Association

By Joseph R. Draney, President The Asphalt Association, New York City

Few, if any, industries are unorganized in this day of concerted industrial effort. Such organization is essential not merely to the industries concerned, but in a broader sense it promotes the general welfare of the nation.

The Asphalt Association was organized in 1919 to place the asphalt industry in the march of progress along with the many other industries which had already organized. Our primary purpose was to obtain by investigation and scientific research, information and data which might prove useful in developing the best methods for the use of asphalt, particularly in paving, and for making known the essential characteristics and qualities possessed by asphalt which render it desirable under given conditions.

Equipped with such basic information and data it was our purpose to disseminate very widely our findings, utilizing every available agency including brochures and circulars, lectures, moving pictures, educational matter in the public press and personal contact. We have scrupulously avoided any policy or practice even remotely concerned with the regulation of prices, the apportionment of territory, the control of output or in any way constituting a restriction upon the freest and most unhampered competition among asphalt producers. We have taken extreme care to avoid any violation of not only the letter and spirit of the laws of the land but also the ethics of business as well. Also I might add that our work is wholly on constructive lines.

It is a fundamental policy with The Asphalt Association to give out such correct information as will result in the adoption of the best possible methods in the use of asphalt, particularly for paving, and that the information be sufficiently comprehensive to cover every type of asphalt pavement and every method of using asphalt for other paving purposes. We conscientiously believe that asphalt is an enduring and exceedingly useful paving material and we believe that we can increase its popularity by making widely known its qualities and the correct methods for its use.

A Clearing House for Information

Prior to the formation of the association there was little coordination of the various facts and theories concerning asphalt. There were many and conflicting specifications. Workable instructions covering the uses of asphalt were scattered in many publications and much of the data was locked up in the minds of men who had the knowledge but had not made it public in printed form. There was no recognized clearing house for knowledge or fountain-head of authority on questions relating to asphalt paving. The association has provided such a clearing house and fountain head.

We have, through our Technical Committee, at the head of which is Mr. Prevost Hubbard, formerly Chief of the Division of Research at the U. S. Bureau of Public Roads, prepared and issued specifications covering every type of asphalt pavement. These specifications are now regarded as authoritative. We have issued a comprehensive series of brochures and circulars giving simply and clearly essential information as to paving methods. These publications are products of the best minds in the industry, as we have, in addition to the regular staff of the association, all of the technical knowledge possessed by the engineers and chemists of the various member companies. We are justified, therefore, in saying that the information we give out may be regarded as sound and workable. The management of the association and the many economic questions involved in the work are handled by the Secretary, Mr. J. E. Pennybacker, who was formerly Chief Highway Economist for the Federal Bureau of Roads.

Leading colleges and universities, including such representative institutions as Yale University, the Masschusetts Institute of Technology, the University of Michigan and the Georgia School of Technology, now include in their courses of engineering construction, illustrated lectures on asphalt paving delivered by representatives of The Asphalt Association. We believe that a thorough knowledge of asphalt and its uses in paving should be possessed by the engineer graduate and we are successfully bringing this about with a resultant benefit both to the taxpayers and the industry.

In our research work we are cooperating with the U. S. Bureau of Public Roads and various municipal engineering organizations. Just now we have studies under way in which we are cooperating with the Federal Bureau and the city engineers of New York, Philadelphia, Baltimore, Washington and Detroit. We have conducted investigations and tests on our own account concerning the resistance of asphalt to impact and have developed some highly important facts which should influence paving design. Our cooperation with the government has also resulted in the production of some excellent moving pictures showing the construction of various types of asphalt pavements. This

cannot fail to be helpful as the pictures are loaned by the United States Bureau of Public Roads upon request for exhibition purposes.

No Buyer's Strike Necessary

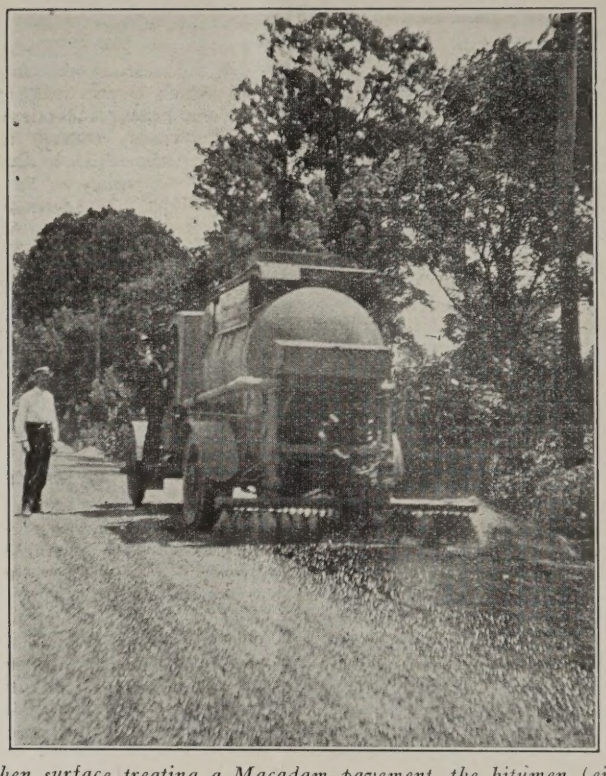
Reports state that the highway departments of Illinois, Iowa, Kansas, Michigan, Minnesota, Missouri, South Dakota and Wisconsin not long ago declared a buyers' strike against cement manufacturers and in consequence about $100,000,000. of highway construction was held up. We cannot see why the price of this single material should serve to hinder road building in the slightest degree, because there is sufficient asphalt at present to cover a wide and comprehensive program of road building. If the various state highway departments desire to hold out against cement that is no reason why the progress of road building should be hampered. Asphalt is used in a larger mileage of pavements than Portland cement. Fifty-five per cent, by area, of city pavements is asphalt. Fifth avenue, New York; Michigan Boulevard, Chicago; Broad Street, Philadelphia; and the most famous avenues and boulevards of this country and Europe are paved with asphalt and such pavements can be duplicated on country roads at little, if any, more than the cost of unsurfaced Portland cement concrete pavements. Asphalt is now selling at a lower price than in 1913, the pre-war year.

In California the asphalt top is laid on a base composed of a mixture of asphalt and stone so that the entire slab is flexible and water-proof. It does not shatter under traffic but yields just enough to conform with the subgrade and in consequence is almost indestructible. I am not here to criticise Portland cement concrete or any other type of pavement but it seems incredible that any highway department should actually defer a paving program because of the high price of a material which is not an absolute essential. It cannot be claimed truthfully that a type of pavement which withstands the enormous traffic of our principle cities as well as many of the best state highways and which is practically no more costly than unsurfaced Portland cement concrete, is not good enough for our country highways. Asphalt is marketed upon a keenly competitive basis which is illustrated by the very sharp differences in bid prices by the various producers at the different lettings. The competition in asphalt is more pronounced than almost any material or article used in public works.

Freight Rates Reduced on Asphalt

The Asphalt Association has obtained reductions in freight rates on asphalt in the belief that this would benefit the taxpayers and stimulate road building and we have consistently opposed tariff duties on imported crude oil as we felt that this would add to the burden of the consumer. In short, we have endeavored to square the interests of the industry with those of the public and to make the association an organization of widespread general usefulness.

We are not content to stand still or to take it for granted that we have a complete grasp of asphalt paving problems. While we have the benefit of the services of much of the best talent, we are glad at all times to receive suggestions from those who are considerate and generous enough to give them to us. At the same time we invite every engineer, highway official and contractor to call upon the association for information and advice about any question relating to the use of asphalt. We are always willing and ready to cooperate with those engaged in the use of asphalt with the idea of reaching as nearly a maximum of efficiency as is possible.



When surface treating a Macadam pavement, the bitumen (either hot or cold oil) is applied by means of large pressure distributors mounted on auto trucks.

General Discussion of Draney's Paper

COL. WHITTEMORE: Gentlemen, I am sure it seems to me that this is a very interesting paper—of such widespread interest and great importance that it will prompt some of you gentlemen who have been active in using asphalt in building pavements to ask questions that may be in your mind in reference to this matter. I know Mr. Draney will be very glad to answer them if they are answerable.

COMMISSIONER DOUGHTY: You speak about a tariff on asphaltic cements. Can you tell me what the relative tonnage of foreign asphalt used is in comparison with domestic asphalt?

MR. DRANEY: The tariff is on the crude oil. Because of the proposed tariff on crude oil it affects the importation of Mexican petroleum from which asphalt in this country is derived. Practically 60 per cent. of the asphalt is derived from Mexican petroleum.

COMMISSIONER DOUGHTY: What is the physical difference between California and Mexican asphalt?

MR. DRANEY: Very little difference. Mexican asphalt is heavier, that is all. It is a scientific relation. California asphalt is higher in petrolene. Mexican asphalt has a little more body.

COMMISSIONER DOUGHTY: I always understood there was a physical difference between the two.

MR. DRANEY: With reference to California asphalt it is a matter of taste and judgement. It is more susceptible to extremes of temperature changes than Mexican.

MR. GAGE: I would like to ask Mr. Draney if he thinks mixing 40% of an asphaltic residue secured from mid-continental petroleums improved the quality of the Mexican cement.

MR. DRANEY: Personally, I do not.

MR. GAGE: Neither do I. Yet it is often claimed that this mixture is superior to the pure Mexican. I am glad that we agree on this point.

COL. WHITTEMORE: It appears to be a remarkable thing that you two agree.

MR. ROBBINS: I would like to ask a question. Mr. Draney made a statement in his paper as to the high price of Portland cement as holding up the work in certain states. I do not see why the price of this material should interfere with this work, inasmuch as the streets of cities are subject to heavy traffic and are built with asphalt. County roads could be built likewise. I think Mr. Draney admitted the type of base used in cities.

MR. DRANEY: There are a great many types of base which might be used, such as rolled stone base or asphalt on old base, or existing macadam foundation. Asphalt is used very extensively in France. In other words, we contend that just because certain people think Portland cement is too high, that should not retard building good roads. There is other material in the market just as good.

MR. ROBBINS: Bituminous type of base is equally as satisfactory as Portland cement base.

MR. DRANEY: As far as asphalt base is concerned, I only know just what we have learned from experiments in France. We claim at least 15,000,000 square yards of this type laid has given very satisfactory service. Macadam base was laid in Bergen, Passaic, and Morris Counties, and gives ample evidence of satisfaction. I do not think there is a better informed paving man than George Warren. He contends that a well compacted macadam base of the proper depth will always give satisfaction. Allegheny County, adjacent to Pittsburgh, has a great deal of asphalt on macadam. They provide for a sufficient amount of macadam.

MR. ROBBINS: Mr. Draney referred to the excellent service given by asphalt in cities. What type of base does he refer to?

MR. DRANEY: Have had excellent results with both bituminous and concrete base. Not only on concrete but on concrete made with natural cement, and not Portland cement. Millions and millions of yards were laid years ago on natural cement bases, and not the improved Portland cement.

MR. ROBBINS: It is true that in Philadelphia a considerable mileage was relaid on macadam and telford base. How is it in New York City?

MR. DRANEY: In New York City the section known as Manhattan has never had any macadam to speak of, except in the parks. Consequently there is no macadam to cover. Though in the Bronx they did cover some and in

Before surface treating a Macadam road, it should be brought to a true cross section by patching all holes in the manner shown above. Route No. 13

the Borough of Queens. In the Borough of Queens in 1912 they paved many miles of asphalt on macadam, and today it is standing up very well.

MR. ROBBINS: To what extent are the bases in New York Belgian Block?

MR. DRANEY: I do not know. A great deal in the 90's was relaid on Belgian Block. This is not a good base, as it shifts so that one block would be up and another would be down.

COL. WHITTEMORE: We have with us a man connected with the Highway Department of New Jersey so long that "the memory of man runneth not the contrary." If Mr. Meeker would tell some of his experiences I believe it would be a great benefit to the audience here assembled.

MR. MEEKER: I thought you meant Mr. Gage. With reference to a base for asphaltic concrete, I would say that we can cite one case in Union County of a telford foundation laid in 1873, and when it was relaid, it was resurfaced by the County in 1889. In 1912 a bituminous concrete top was placed on that road, and nothing has been done to it since. I think Mr. Draney's remarks are fully substantiated by the experience we have had of placing bituminous concrete surface on telford base. I do not think there is anything better. I do not know of any concrete base on which bituminous surface has been placed as long ago as 1912 that has not had any repairs to it except where cut into for sewer connections. One trouble with concrete base is that unless you make it very dense the water will get through by capillary action, and it is a well known fact that water does oxidize asphalt. Telford is open, and forms a natural drainage course. Asphalt will last longer on good telford than on a good concrete base, as far as my experience goes.

COL. WHITTEMORE: Any more questions, Gentlemen?

MR. ROSINGARDIN: Mr. Pickney, Chief Engineer of Manhattan and New York City, a year ago made a ruling that all repairs to cuts in Fifth Avenue must be replaced by bituminous concrete base. In the future, they will use a binder mixture, 7½ in. in depth. Formerly Fifth Avenue had a Portland cement concrete base.

COL. WHITTEMORE: What is the total thickness of the repair, including base?

MR. ROSINGARDIN: 7½ in., to make the same depth as the original pavement.

MR. KORP: Is it possible to lay any pavement on Fifth Avenue other than asphalt, because of tying up traffic for a certain length of time?

MR. DRANEY: They might resurface with brick, wood block or granite.

MR. KORP: No, I mean the reason it is used is because of tying up traffic for a certain length of time. Is that the reason?

MR. DRANEY: I do not think that has anything to do with it particularly. What is put down for the next 15 or 20 years would not be influenced by a delay of 10, 15 or 20 days now.

MR. KORP: I thought that was the reason, because asphalt is a quick pavement to put down, and not tie up traffic.

MR. DRANEY: I do not think they would use it if it saved a few days and then were cut to pieces within several months. I think there must be some other reasons for its use besides those that you state.

MR. GAGE: The proper foundation to lay for a bituminous pavement appears to be a very live issue at the present time. Each locality appears to have its favorite type of base and is satisfied with the results secured with it. Our own experience shows that more bituminous pavements are injured by bad or improper foundations than by traffic or the use of inferior grades of asphalt cement. There is little doubt but that most failures in bituminous pavements are not caused by the use of inferior grades of materials but can usually be traced to bad workmanship or faulty foundations. It has also been our experience that traffic does not hurt an asphalt pavement, but, on the contrary, benefits it unless the traffic is very severe. It is also safe to assume that over 90% of the failures in asphalt pavements can be traced to disintegration of the asphalt cement with subsequent raveling, instead of failure caused by the wearing out of the ingredients in the pavement. If the life of an asphalt cement can be maintained, bituminous pavements will last from twenty-five to thirty years, but we know that it is very seldom that they have any such life. The reason for this shortened life can easily be traced directly to the injury done by surface or sub-surface waters. It is usually recommended that a subgrade be properly drained, yet it is seldom that they are so drained. A macadam base is never dry, yet we frequently see an old macadam road, that is heaved out of shape by frost on account of bad sub-drainage, resurfaced with a bituminous pavement without the addition of the necessary stone for stability or the installation of a good drainage system. The tendency appears to be to expend most all available funds on the surface pavement. Under such conditions, it is not surprising that failures frequently occur in bituminous pavements constructed on macadam foundations, also in a concrete foundation, the density is just as important as the strength. A porous concrete holds the water in the same manner as a sponge and concrete of this character usually is deficient in strength; consequently, when a heavy load passes over the pavement the water is squeezed from the subgrade and concrete, up into or against the surface pavement. Here again, the initial cost is the controlling factor, for there is little doubt but that a strong, dense concrete is superior in every respect to a porous, understrength concrete The unfortunate part of this matter is that it is very hard to estimate the damage done a bituminous pavement by improper foundations or convince the average person, unfamiliar with road work, that it is false economy to construct expensive surfaces on cheap, unstable foundations.

MR. KEASBEY: I would like to ask Mr. Draney if in his experience in the construction of bases under asphalt pavements, he has had any experience in reducing the thickness of the stone base by using first-class gravel instead of putting in five or six inches of stone base.

MR. DRANEY: I think that would be a benefit. It should be especially well compacted where the drainage is good. I have had no experience of that kind that I can recall, yet I do not see why it would not be a good proposition.

MR. KEASBEY: The idea being, of course, to reduce the cost of the base.

After the Bitumen has been applied, covering material, such as stone chips, slag or gravel, is spread lightly over the surface, as shown in the above picture taken on Route No. 13

MR. DRANEY: Traffic is a big factor in that.

MR. WILLIAMS: In reference to what Mr. Keasbey was saying, I can answer his question. Most of the bituminous roads laid in Cape May County in this state are about the construction Mr. Keasbey asked about. For instance, the Boulevard into Wildwood is 2 in. topeka laid on top of about two inches of stone rolled into an old gravel road. Also, three years ago, on the road extending from West Cape May two miles north on the Ocean Highway, they put in 2 in. of loose slag and rolled that into the old gravel road. In some cases, there was no old gravel road, and they rolled it right into the sand, and from my observation that gives a very good surface in that end of the country. A road in West Cape May was adjacent to some Topeka laid the same year. There were two contracts, one Topeka laid on concrete base and the other, Topeka of same mix and same thickness laid on macadam base. The macadam type is showing up the best. Mr. Gage might give additional information.

MR. GAGE: I think the State only participated in that section constructed on the concrete foundation. Both this concrete and the Topeka surface was built of local materials as an experiment. Instead of the usual ¼ in. to ½ in. stone, a similar size gravel was used in the bituminous surface. This same quality of gravel has been used in a concrete surface very successfully, but we found when used in a bituminous surface pavement that it was easily shattered by traffic. In the former case, the pebbles were held rigidly in place and supported on the sides by the concrete mortar; while in the bituminous pavement, the pebble was supported by a resilient cushion of bituminous mortar. The results thus secured are just the reverse of what one would expect for it is claimed that pavements should have a certain amount of resiliency to protect them against disintegration caused by the impact of motor vehicles. To date, this pavement has not raveled, but shows the effects of the shattering and disintegration of the small gravel pebbles very noticeably.

COL. WHITTEMORE: It seems very necessary to be particular about the ingredients in any kind of a mixture.

MR. GAGE: Yes, that is true.

MR. BRAGG: Quite a lot has been said in favor of types of foundation other than concrete. I would like to know how many failures we have of bituminous pavements laid on proper concrete bases, properly drained.

MR. HUBBARD: I do not think anyone will attempt to gainsay that concrete makes an excellent base under the surface. The record of Portland cement concrete as a base for bituminous pavements proves the contrary if such an assertion is made. I do not think that is the point, exactly. The point is that other materials may be successfully used as a base and give just as good service. This has been demonstrated by experience. It isn't an attack on concrete base that the Asphalt Association makes in bringing to the attention of Engineers the advantage of other types of base. It is merely showing the possibility of broadening out and using other materials.

MR. SMITH: For the benefit of some men—as I do not see anyone from the Camden County Engineer's office—take the White Horse Pike when speaking of foundations, a place where perhaps you all had a chance to look at. When leaving the concrete at Berlin coming toward Camden, Mr. Albertson experimented with that short stretch from the point where the concrete begins in to Berlin. The base is Tarvia X under Amiesite. I can't tell the thickness. In some sections he used only an inch of Amiesite. He has told me a good many times that he is very proud of his experiment with a bituminious base on that section. Mr. Albertson thinks that this has shown up as one of the best pieces of road that he had. It is at the point leaving the concrete coming in to Berlin. It is still today in excellent condition.

MR. WILLIAMS: I saw that put down. It was laid in two courses 4" of loose stone rolled down to 3", ballast size stone and 1½" stone penetrated with 1¾ gallons of asphalt; 125 pounds of asphalt filler. This is the standard construction around Camden County, Browning Road and Collingswood are the same thing. The County this summer also had fixed up Browning Road from Kane Avenue to Merchantville. The standard construction seems to give satisfaction. The piece Mr. Smith speaks of was put down six years ago. Only one hole the size of your hand has developed. The piece is 16 feet wide. It has a rather high crown which might explain some of the stand-up qualities.

COL. WHITTEMORE: Any more questions, gentlemen? I would like to emphasize most clearly that road construction is an engineering problem and no matter what material is used, you can get a good road for certain kinds of traffic if approached from an engineering standpoint, whether by getting rid of water by providing for drainage or by handling a certain kind of material a certain way. You can't get a good road by any hard and fast rules, so that any amateur can dig it out of a book and go to any certain section of the country, say California, and say this is a good road in New York. Out of my experience I feel at liberty to state that road building is an engineering problem and must be handled by men with an engineering turn of mind to see what the conditions are, and then design and build roads in accordance with those conditions. It is a dangerous thing to make up specifications with the use of a mucilage pot and a pair of shears.

Discussion of Mr. P. P. Sharples' Paper

By W. H. Fulweiler, U. G. I. Contracting Company

For many years, Mr. Sharples and I have been on opposite sides of the fence so that it is a very great pleasure for me to be on the same side as Mr. Sharples is this morning.

I was particularly glad to hear Mr. Sharples stress the importance of maintenance. About twelve years ago we had to make a decision as to whether we would devote the bulk of our time to construction or to maintenance. I felt that maintenance was after all, or certainly at that time, of greater importance than construction work. It has appealed to me that a road is only built once, but it must be maintained forever, at least until that marvelous road comes in the future that will need no maintenance.

One of the very important requirements in connection with maintenance work is a uniform system of accounting that will enable engineers readily and accurately to compare the cost of maintenance of different types of road and under different traffic and climatic conditions. It is difficult to see how real progress can be made without such a system of accounting. There are a great many factors entering into the maintenance cost and there are many ways of expressing these factors. As a result, in a large number of cases, the printed maintenance costs are almost meaningless and in some cases, result in giving very false impressions regarding the cost to the taxpayers of different classes of road surface.

There is no question but that much of our present difficulty with the maintenance of macadam roads is due to the fact that they are really not macadam at all. If you dig into many of our so-called macadam today, you will find a few pieces of stone and a large amount of dirt and stone dust. I maintain that this is not macadam. It may have been macadam, but it has lost that characteristic which I hold should be the presence of a number of relatively large sizes of angular pieces of stone mechanically bonded with smaller sizes of stone.

It would appear from a considerable amount of inspection work that it is difficult to secure the proper interest in the resurfacing and construction of true macadam roads, but there is no question that a real macadam road maintained with surface treatments will today give excellent service under the present existing traffic.

Many of our older macadam roads were not provided with adequate foundations and in some cases, the failure of the foundation is the principal cause of high maintenance costs.

In connection with foundation work, I feel that we still have much to learn regarding sub-grade conditions and I believe the investigation that has recently been undertaken by the Bureau of Public Roads cannot help but yield very valuable results in giving us fundamental information about different types of sub-grade conditions.

Another feature of foundation work that has not been given the consideration it is entitled to is the internal wear as a result of the loads that the road has been called upon to carry for so many years.

In many cases, the high cost of maintenance is due to the fact that the roads are entirely unsuited for the traffic they are compelled to bear due to shallow foundations and poor sub-grade. If these roads instead of simply being resurfaced with stone were rebuilt with deeper and more adequate foundations and give a proper macadam surface and then maintained with bituminous materials, in probably 90% of our traffic conditions such a road would give a surface that is pleasant to drive over, non-skiding in wet weather and one that readily frees itself from snow and sleet in winter months. This latter point is interesting in that I have recently watched a bituminous surfaced road and a concrete road during the recent snow fall. Two days after the snow ceased the bituminous road with a dark top was clear of snow and dry, while the concrete surface was still entirely covered with snow.

In connection with penetration work this type of construction has been subjected to considerable criticism in recent years, yet there is no question but that when properly constructed the penetration road yields excellent results. It would appear that it is due to the apparent simplicity of the work and that the unsatisfactory results have been entirely due to a lack of attention to necessary details.

Ninety per cent of the life of a road is due to inspection. You may have the best engineers, the very best plans and specifications, the very best materials, but if there are no inspectors to see that they are properly put together, you will not get the successful results that you deserve. I want to make a plea for the inspector. An inspector is born and not made, and the supply is limited. You cannot take a man from a steel shop or drafting room, give him a set of specifications, some report blanks, and your blessing, and expect him to build a good road.

I think practically all of the prejudice against penetration work is due to this. Contractors have taken a job under extreme competition at a low price, have had an unfortunate inspector, and the results were not favorable. An inspector must be many things. First, he not only has to be a diplomat, but has also to be an engineer, and boiling all these things down, good inspectors are few and far between.

One point in connection with the penetration work that seems to me to be of very great importance is the fact that satisfactory results cannot be obtained unless the upper course that is to be filled with bitumen is uniform in thickness. In many cases, roads are resurfaced by the penetration method and the 1½ in. stone in the top course is spread over the old irregular surface with the result that in some places there may be 2 in. of stone while in other parts there may be 6 in. It is obviously impossible to secure uniform distribution of the bituminous binder on such a surface. There seems no question that when properly performed, scarifying the old surface and bringing it to a uniform cross-section is an economical proposition.

I have seen many jobs, however, where I do not feel that the scarifying gave the results that should have been obtained. Scarifying as I understand it does not simply mean tearing up the surface and rolling it back again. My understanding is that it should consist in loosening the whole upper surface of the road, eliminating the worn out dust from the upper surface and bringing into that surface new angular fragments of stone so that you have clean angular large size stone in that wearing surface. In many cases, no attempt is made to get rid of the dirt. In these cases, I think much of the value of the scarifying is lost.

In connection with shoulder work, I would like to call attention to a considerable amount of work of this type which involves extension of the bituminous shoulder beyond the paved portion of the road, that has been done in Maryland with cut back materials and has required very simple equipment. This work has been very successful in adding practically 4 ft. to the usable width of the road at a minimum of expense and with no interruption to traffic.

In connection with the use of gravels in road construction, I feel that the time is more than ripe when this whole subject should receive serious study by road building authorities to the end that some system of nomenclature should be adopted so that when we use the term, let us say, gravel, we mean something definite. At present, gravel covers almost anything from the clean pebbles up to the cobble size that we have in New England to the clay carrying gravels of South Jersey.

In connection with the use of cutback tar materials for maintenance patching, I feel that the use of central mixing plants where machine mixing may be employed, would

result in more efficient and economical work, as the mixtures made in this manner could be made more uniform in their bitumen content.

Mr. Sharples has spoken of the use of cut materials for use in emergency repairs, on city streets. I might relate an experience we had in a large city in western New York where the gas company secured permission to make temporary repairs of their street openings during the winter months. They used quite a large amount of cutback tar for several years, when suddenly permission to make these patches was recalled. Investigation showed that the reason was due to the fact that the asphalt company that had the contract to make these repairs was only able to find about one-half the patches in the spring, and they objected to the loss of this business.

It is probable that considerable economies might be effected in connection with the equipment used for patrol and maintenance work. One thought is the suggestion to use creosoted material for building the platforms for stone and cradles for holding the drums. Such creosoted material would have a very much longer life and would permit the use of better grades of lumber. There are a number of small details that are well worthy of a better thought such as the proper weight and shape of the tamper. Some makes of picks keep their edge very much longer than others. A rustless wire broom would be a great aid. A little care in specifying the material used in filling both the large and small brooms would greatly increase their life.

In concluding, I wish to state that in my opinion maintenance work is one of the most important propositions and has not been given the prominent place it deserves, probably because it is hard work and mighty little glory, but there is no branch of road work where a little intelligence mixed with the stone and the binder will return a greater profit.

Contract News

Prepared to October 9th, 1922

Jan. 11—Route No. 6, Section 8, Pearl St., Bridgeton, Reinforced Concrete paving job, 0.455 miles, 20 and 30 feet wide with gravel shoulders was awarded to the Tri-State Construction Company, Bridgeton, N. J., on their low bid of $76,302.36.

Feb. 8—Route 6, Section 5, Shirley-Oldman's Creek, Reinforced Concrete Paving job, 6.812 miles, 20 feet wide with gravel shoulders, was awarded to the Benjamin Foster Company, Philadelphia, Pennsylvania, on their low bid of $254,021.53.

Feb. 16—Route 6, Section 6, Oldman's Creek-Mullica Hill, Reinforced Concrete Paving job, 5.028 miles, 20-30 feet wide with gravel shoulders, was awarded to the firm of M. Staub, Swedesboro, New Jersey, on his low bid of $203,660.48.

Feb. 24—Route 14, Section 5, Cape May Court House to Swainton, Reinforced Concrete paving job, 2.987 miles, 20 feet wide with gravel shoulders, was awarded to the firm of Sutton and Corson, Ocean City, New Jersey, on their low bid of $118,776.16.

Mar. 8—Route 6, Section 10, Quinton to Marlboro, Grading and Graveling job, 5.994 miles, 20 feet wide, with earth shoulders, was awarded to the Masterson Construction Corporation, New York City, on their low bid of $79,793.17.

Mar. 8—Route 6, Section 11, Salem to Quinton, Reinforced Concrete paving job, 2.648 miles, 20 feet wide with gravel shoulders was awarded to Joseph F. Burke, of Plainfield, New Jersey, on his low bid of $111,833.79.

Mar. 8—Route 4, Section 9, Smithville-Mullica River, Warrenite Bitulithic job, on concrete base, 3.748 miles, thirty feet wide, with gravel shoulders was awarded to C. H. Earle of Hackensack, New Jersey, on his low bid of $374,533.77.

Mar. 8—Route 10, Section 1-B, Arcadian Way to Anderson Ave. in Fort Lee, Reinforced concrete paving job, 0.48 miles, 20 and 30 feet wide with earth shoulders, was awarded to the firm of John J. McGarry, Edgewater, New Jersey, on his low bid of $104,362.61.

Mar. 15—Route 11, Section 1, Main Street, Passaic, Sheet Asphalt job, on Concrete Base, 0.257 miles, 22 feet, 2 inches wide, was awarded to Union Building Construction Company, Passaic, New Jersey, on their low bid of $15,160.15.

Mar. 23—Route 4, Section 6, Eatontown-West Long Branch, Sheet Asphalt job on Concrete Base, 2.69 miles, 20 feet wide with earth shoulders was awarded to the Utility Construction Company of New Brunswick, New Jersey, on their low bid of $149,679.74.

Apr. 4—Route 2, Section 3, South Broad Street Storm Drain job was awarded to A. G. Thompson, of Trenton, New Jersey, on his low bid of $17,665.06.

Apr. 4—Route 2, Section 3, South Broad Street, Sheet Asphalt job, on Concrete Base, 0.648 miles, 48.5 feet wide, was awarded to J. J. Barrett, Trenton, New Jersey, on his low bid of $69,433.77.

Apr. 12—Route 6, Section 9, Salem-Collier's Run, Reinforced Concrete Paving job, 4.752 miles, 20 feet wide with gravel shoulders was awarded to Sampson & Reuter, Elizabeth, New Jersey, on their low bid of $196,975.08.

Apr. 15—Route 3, Section 8, Camden-Clements Bridge Road, Reinforced Concrete Paving job, 3.82 miles, 36 and 40 feet wide with earth shoulders was awarded to W. Penn Corson, Camden, N. J., on his low bid of $269,644.85.

Apr. 15—Route 3, Section 9, Clements Bridge Road to Kirkwood, Reinforced Concrete Paving job, 3.756 miles, 29 feet wide with earth shoulders was awarded to John M. Kelley Construction Co., Camden, N. J., on their low bid of $200,592.95.

Apr. 15—Route 3, Section 10, Kirkwood-Berlin, Reinforced Concrete Paving job, 5.576 miles, 29 feet wide with earth shoulders was awarded to John M. Kelley Construction Co., Camden, N. J., on their low bid of $297,993.89.

Apr. 18—Route 15, Sections 2 and 3, Bridgeton-Millville, Warrenite Bitulithic on Concrete base, 8 miles, 20 feet wide with gravel shoulders was awarded to the Tri-State Construction Company of Bridgeton, New Jersey, on their low bid of $455,500.12.

Apr. 18—Route 4, Section 14, Laurelton-Lakewood. 3.875 miles, Reinforced Concrete Paving job, 20 feet wide with gravel shoulders was awarded to C. H. Earle of Hackensack, New Jersey, on his low bid of $144,705.68.

Apr. 19—Route 4, Section 10, Shadow Lawn-Roseld Avenue, Sheet Asphalt Paving job on Concrete Base, 2.41 miles, 20 and 36 feet wide with earth shoulders, was awarded to Newark Paving Company, of Newark, New Jersey, on their low bid of $104,969.51.

Apr. 19—Route 4, Section 12, Sea Girt Avenue, Reinforced Concrete Paving job, 0.162 miles, 20 feet wide with earth shoulders was awarded to T. H. Riddle, New Brunswick, New Jersey, on his low bid of $8,569.23.

Apr. 21—Route 9, Section 6, Somerville-Bound Brook, Reinforced Concrete Paving job, 2.491 miles, 20 feet wide, earth shoulders was awarded to Salmon Brothers, Netcong, New Jersey, on their low bid of $131,710.10.

Apr. 24—Route No. 4, Section 5-A, Storm Drain in Red Bank, was awarded to Chas. J. Romano, Montclair, New Jersey, on his low bid of $15,314.85.

Apr. 25—Route 5, Section 5, Madison Avenue, Madison Township and Borough of Madison, Warrenite Bitulithic on Concrete base, 2.032 miles, 20 feet wide with earth shoulders, was awarded to the Northern Construction Company, of Newark, New Jersey, on their low bid of $117,-844.37.

Apr. 28—Route 4, Section 13, Richmond Ave., Point Pleasant Beach, Reinforced Concrete paving job, 0.848 miles, 20 feet wide with earth shoulders was awarded to C. H. Earle of Hackensack, New Jersey, on his low bid of $35,471.76.

May 9—Route 9, Section 5, Union Avenue, Bound Brook, Sheet Asphalt on Concrete Base, 1.501 miles, 20 feet wide with earth shoulders was awarded to the Utility Construction Company of New Brunswick, New Jersey, on their low bid of $93,090.31.

May 26—Route 4, Section 15, Lakewood (County Section) 2.556 miles Reinforced Concrete Paving job, twenty-eight and thirty feet wide, was awarded to the Public Service Production Company of Newark, New Jersey, on their low bid of $75,748.82.

May 26—Route 4, Section 15, Lakewood (Township Section) 2.556 miles, Reinforced concrete paving job, 36 and 50 feet wide was awarded to C. H. Earle of Hackensack, New Jersey, on his low bid of $105,741.10.

May 26—Route 9, Section 8, North Branch-Somerville, 3.837 miles, Reinforced Concrete paving job, 20 feet wide with earth shoulders was awarded to Ralph Sangiovanni, on his low bid of $159,077.59.

May 26—Route 16, Section 3, Bedminster-Plukamin, 2.415 miles Reinforced Concrete paving job, 20 feet wide with earth shoulders was awarded to Ralph Sangiovanni, on his low bid of $135,648.39.

May 26—Route 4, Section 16, Maine St., Toms River, 1.096 miles long, Reinforced Concrete paving job, 20, 30, 36, 38 and 56 feet wide with gravel shoulders was awarded to the Public Service Production Company of Newark, New Jersey, on their low bid of $62,864.59.

June 8—Route 5, Section 9, Barker's Corner-Hackettstown, 2.99 miles Reinforced Concrete paving job, 20 and 48 feet wide with earth shoulders was awarded to Frank J. Groman, of Bethlehem, Pennsylvania, on his low bid of $230,274.37.

June 8—Route 9, Section B, West Front Street, Plainfield, Sheet Asphalt paving job on Concrete Base, 1.929 miles, 40 and 41 feet wide, was awarded to the Union Paving Company, of Newark, New Jersey, on their low bid of $219,316.20.

June 10—Route 6, Section 12, East Commerce Street, Bridgeton, 1.314 miles long. Sheet Asphalt paving job on

Concrete Base, 20 and 32 feet wide, was awarded to E. K. Mixner Co., on their low bid of $80,422.01.

June 20—Route 2, Section 3-A, Whitehorse-Crosswicks Creek, 0.389 miles, Reinforced Concrete paving job, 30 and 40 feet wide was awarded to Daniel Klockner, of Trenton, New Jersey, on his low bid of $37,472.82.

June 21—Route 5, Section 6, Speedwell Avenue, Morristown, Warrenite Bitulithic surface on Concrete Base, 1.426 miles, 23 feet, 3½ inches wide was awarded to J. S. Geiger Sons of Newark, New Jersey, on their low bid of $144,892.74.

June 21—Route 9, Section 9, Phillipsburg-Still Valley, Reinforced Concrete paving job, 1.68 miles, 20 and 36 feet wide with earth shoulders was awarded to Crilly and Cannon of Phillipsburg, New Jersey, on their low bid of $110,345.40.

June 28—Route 1, Section 6, Trenton City Line-Nottingham Way, reinforced concrete paving job, 0.928 miles, 39 feet, six inches wide, was awarded to Rees and Taylor, of Trenton, New Jersey, on their low bid of $95,347.47.

June 28—Route 4, Section 11, Main Street, Avon, New Jersey, Warrenite Bitulithic surface on Concrete Base, 0.663 miles, 43 feet wide with earth shoulders was awarded to the East Jersey Bridge Company, of Perth Amboy, New Jersey, on their low bid of $54,814.34.

July 7—Route 4, Section 17, Barnegat, Reinforced Concrete job, 1.0 miles, 20 feet wide with gravel shoulders, was awarded to the Public Service Production Company of Newark, New Jersey, on their low bid of $43,931.94.

July 7—Route 4, Section 18, Tuckerton, Reinforced Concrete job, 1.5 miles, 20 feet wide with gravel shoulders, was awarded to the Public Service Production Company of Newark, New Jersey, on their low bid of $59,913.83.

July 13—Route 9, Section 7, Main Street, Somerville, Reinforced Concrete job, 0.497 miles, was awarded to J. L. Bachman of Linden, N. J., on his low bid of $74,180.25.

July 14—Route 16, Section 2, Mine Mount Road-Bedminster Corner, Reinforced Concrete job, 2.515 miles, was awarded to the Engineering Construction Corporation, Philadelphia, Pennsylvania, on their low bid of $166,802.65.

July 17—Route 9, Section 9-A, Still Valley-Bloomsbury, Reinforced Concrete job, 2.92 miles, was awarded to Bernard E. Tighe Construction Company of Easton, Pennsylvania, on their low bid of $127,785.84.

July 21—Route 5, Section 8, Great Meadows-Barker's Corner, Reinforced Concrete, was awarded to Salmon Bros., Netcong, New Jersey, on their low bid of $186,688.69.

July 25—Route 1, Section 13, Highland Park-Stelton Road, Warrenite Bitulithic on Concrete Base, was awarded to S. S. Thompson & Company, Incorporated, Red Bank, New Jersey, on their low bid of $305,394.61.

July 25—Route 1, Section 14, Stelton Road-Metuchen, Warrenite Bitulithic on a Concrete Base, was awarded to S. S. Thompson & Company, Incorporated, Red Bank, New Jersey, on their low bid of $344,784.65.

Aug. 9—Route 15, Section 4, Millville, Warrenite Bitulithic Surface on Concrete Base, 0.986 miles, 20 feet wide, was awarded to the Tri-State Construction Company, of Bridgeton, N. J., on their low bid of $55,796.67.

Aug. 10—Route 6, Section 14, Woodbury, Reinforced Concrete paving job, 1.505 miles, 20 feet wide and 46 feet wide, was awarded to the Public Service Production Company of Newark, N. J., on their low bid of $169,775.88.

Aug. 18—Route 10, Section 3, Little Ferry-Ridgefield, Reinforced Concrete job, 1.76 miles, 20 to 30 feet wide, was awarded to John J. McGarry, of Edgewater, N. J., on his low bid of $146,760.88.

Aug. 18—Route 10, Section 5, Hudson Street, Hackensack, Sheet Asphalt job, 1.449 miles, 20 ft. 4 in. and 42 ft. 6 in. wide, was awarded to G. M. Brewster, Tenafly, N. J., on his low bid of $140,205.49.

Aug. 18—Route 10, Section 5-A, Essex Street, Hackensack, Reinforced Concrete Paving job, 0.346 miles, 22 feet wide, was awarded to Ufheil and Phelan, Hackensack, N. J., on their low bid of $24,323.09.

Sept. 15—Route No. 7, Section 1, Corlies Ave., Neptune Township, Warrenite Bitulithic on Concrete Base, 0.949 miles, 33 feet and 38 feet wide, was awarded to the East Jersey Bridge Company, of Perth Amboy, New Jersey, on their low bid of $97,110.68.

Sept. 15—Route No. 4, Section 5-A, Maple Ave., Red Bank, Sheet Asphalt Paving job on Concrete Base, 1.308 miles, 40 feet wide was awarded to the Wm. P. McDonald Construction Company, of New York City, on their low bid of $109,560.95.

Sept. 15—Route No. 9, Section 7-A, Union Ave., Grove St., Somerville, Reinforced Concrete Paving job, 0.778 miles, 20 feet wide, was awarded to the N. J. Construction Company, of Hackensack, N. J., on their low bid of $77,549.47.

Sept. 15—Route No. 16, Section 4, Pluckamin-Somerville, Reinforced Concrete Paving job, 5.475 miles, 20 and 30 feet wide, was awarded to the Peconco Engineering & Construction Company, of New York City, on their low bid of $329,749.09.

Sept. 15—Route No. 1 and 13, connecting link through New Brunswick, Asphalt Block Pavement on Concrete base, 0.874 miles, 37.4 and 45 ft. wide, was awarded to the Utility Construction Company, of New Brunswick, on their low bid of $122,644.48.

Sept. 28—Route No. 14, Section 7, Petersburg-Greenfield, Grading and Graveling job, 1.99 miles, 20 feet wide with earth shoulders was awarded to Ross & Whelan of Trenton, N. J., on their low bid of $85,196.86.

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